

CLAIMS

1. An apparatus for medical screening and diagnosis by dual detection of stethoscopic and Doppler signals, comprising a sound-transmitting linking conduit (3, 33) connected, at one end, to a housing (100) which at least partially forms an ear trumpet (1, 1') provided with a membrane (2), and, at the other end, to at least one earpiece (4) for listening to a stethoscopic signal coming from the ear trumpet, characterized in that the housing (100) is coupled to at least one ultrasound probe (8) designed to permit convergence of reception of the ultrasonic and stethoscopic signals and connected to a transducer processing circuit (37) capable of supplying, from a Doppler signal, an audio signal, by coupling the processing circuit (37) to a loudspeaker (34) in contact with the ear trumpet (1, 1') for stethoscopic-type listening, and a video signal, by coupling the processing circuit (37) to viewing means (31, 32, 39) for providing visual information.

2. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which means are provided for delivering (60, 6a) and forming (6b) a film of semi-solid product (61) on the skin of the patient, in particular a gel, for achieving an intimate contact between skin and housing and for channeling the propagation of the waves.

3. The apparatus for medical screening and diagnosis as claimed in claim 1 or 2, in which a loudspeaker (34) is provided which is arranged substantially against the ear trumpet (1, 1') so that the audio signal is amplified by the ear trumpet and renders the stethoscopic sound perceptible at the earpiece (4) via the linking conduit (3, 33), in the same way as in a stethoscope.

4. The apparatus for medical screening and diagnosis as claimed in any one of claims 1 through 3, in which a microphone (40) is provided which is coupled to the ear trumpet (1, 1') so as to pick up the stethoscopic sound signal and transmit it, in the form of an electrical signal, to the processing circuit (37) and produce a video signal.

5. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, in which the viewing means are in the form of a liquid crystal screen (32) permitting graphic display of a stethoscopic and Doppler signal, or in the form of a module with light-emitting diodes (39).

6. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, characterized in that it comprises a microprocessor controlled by an interpretation algorithm and coupled to the processing circuit (37) in order to permit analysis and a combination of stethoscopic and/or Doppler measurements, delivered by the processing circuit (37) or else picked up from stethoscopic listening, and to be able to supply a stethoscopic diagnosis, Doppler diagnosis and/or cross diagnosis.

7. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, characterized in that it comprises a display module with three light-emitting diodes (39) which is mounted on the housing (100), which shows the interpretation and provides a diagnosis based on the measurement of the Doppler signal or a cross diagnosis based on the interpretation algorithm by giving preference to the Doppler diagnosis when the interpretations are divergent, each diode of the module (39) emitting in a specific color corresponding, respectively, to a positive diagnosis, a negative diagnosis, or a non-interpretable result in the case where at least the Doppler measurement is not interpretable.

8. The apparatus for medical diagnosis as claimed in the preceding claim, characterized in that, instead of displaying a non-interpretable result when at least the Doppler measurement is such, the diagnosis is in this case based on the measurement of the stethoscopic signal, each diode of the module (39) emitting in the specific color corresponding, respectively, to a positive diagnosis, a negative diagnosis, or a non-interpretable result, in the case where the stethoscopic signal is not interpretable, or of malfunction of the apparatus, the diagnosis is then based on the stethoscopic sound signal.

9. The apparatus for screening and medical screening and diagnosis as claimed in any one of the preceding claims, in which a system of recording and viewing the Doppler or stethoscopic video signal is provided by wireless connection between the electronic processing circuit (37) and a viewing or printing module (50).

10. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, in which peripheral outputs (101, 42) are provided in order to permit a connection to a microcomputer and optionally to an audio headset.

11. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, in which, for simple use of the probe in particular with the aid of a finger (35), an electrical circuit (29) is provided for powering the ultrasound probe (8), controlled by an actuator (18, 28, 38) which can be mounted on the linking conduit (3, 33) or on the housing (100).

12. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the actuator is a multifunction switch which serves also for selective control to the means for supplying stethoscopic, Doppler or cross diagnoses (29) by the viewing means (31, 32, 39), to the means for triggering the diagnosis (30) from measurements delivered by the processing circuit (37) or picked up from listening, and to the system for recording and remote viewing (50), the multifunction being realized by different stages identified by a decision table or a logic unit for programming the connections of the circuits as a function of the number of times the actuator (18, 28, 38) is activated.

13. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, in which power supply by cell or by rechargeable battery (23) is also provided.

14. The apparatus for medical screening and diagnosis as claimed in any one of the preceding claims, in which the housing (100) forms the ear trumpet (1) accommodating the ultrasound probe (8), in particular in a centered manner, and in that contact means (7) are provided to be interposed temporarily between the ultrasound probe (8) and the membrane (2) of the ear trumpet (1), in order to transmit a Doppler signal to the processing circuit (37) coupled to the loudspeaker (34) which emits the audio signal amplified in the ear trumpet (1).

15. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the means of interposition comprise an inflatable balloon (7) covering the distal end of the probe (8) and a device (10) for inflating the balloon (7) with liquid.

16. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the inflating device comprises a tubing (6) which brings the balloon (7) into communication with a source of liquid, and means (10) intended to drive liquid from the source into the tubing

(6).

17. The apparatus for medical screening and diagnosis as claimed in any one of claims 14 through 16, in which the means of interposition (7) between the probe (8) and the membrane (2) are controlled from outside the ear trumpet (1) by the actuator button (18).

18. The apparatus for medical screening and diagnosis as claimed in any one of claims 14 through 17, in which means controlled from outside the ear trumpet (1) and intended to tilt the probe (8) are provided in connection with the actuator button (18).

19. The apparatus for medical screening and diagnosis as claimed in any one of claims 14 through 18, in which the means intended to tilt the probe (8) comprise at least one cable (21), of which one end is fixed to the end of the probe (8), and means (12) intended to pull the other end of the cable (21) and tilt the end of the probe in order to orient it toward the sound response most perceptible at the earpiece.

20. The apparatus for medical screening and diagnosis as claimed in any one of claims 14 through 19, in which a circuit (29) is provided for powering the ultrasound probe (8) and controlled by the actuator button (18).

21. The apparatus for medical screening and diagnosis as claimed in one of the preceding claims, in which a circuit (30) is provided for recording the Doppler signal and controlled by the actuator button (18).

22. The apparatus for medical screening and diagnosis as claimed in any one of claims 14 through 21, in which the actuator buttons form a single button, and means (11) are provided which are intended to maintain the flow of liquid when the actuator button is released, these means comprising a plunger (10) made of a magnetic material for driving the liquid, and an electromagnetic coil (11) applying a magnetic force for holding the plunger (10).

23. The apparatus for medical screening and diagnosis as claimed in any one of claims 1 through 13, in which the probe (8) is accommodated in the housing (100) and outside the ear trumpet (1'), the housing forming a substantially cylindrical turret.

24. The apparatus for medical screening and diagnosis as claimed in any one of claims 1 through 13, in which the probe (8) is

accommodated partially in the housing (100) and partially outside the housing, the probe passing through the housing (100) via a sealing ring (75) which mechanically isolates the probe (8).

5 25. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the housing has a lower part (100b) curved in its central area.

10 26. The apparatus for medical screening and diagnosis as claimed in any one of claims 1 through 13, in which the probe (8) is outside the housing (100), which is reduced to an upper part (100a) for signal processing, the probe (8) being fixed along the ear trumpet (1).

15 27. The apparatus for medical screening and diagnosis as claimed in claim 23, in which the probe (8) is inclined toward the central axis (X'X) of the ear trumpet by a fixed angle chosen between 30 and 70 degrees relative to the plane of the membrane (2), preferably between 40 and 55 degrees, so as to optimize the examination by causing convergence of reception of the ultrasound signals and that of the stethoscopic signals.

20 28. The apparatus for medical screening and diagnosis as claimed in claim 23, in which the housing (100) has a turret shape substantially cylindrical and of ovoid cross section, the turret is limited by an upper face (Fs), at the center of which the linking conduit (3, 33) emerges, and by an open lower face (Fi) where the membrane (2) of the ear trumpet (1') and the end (8a) of the probe are positioned.

25 29. The apparatus for medical screening and diagnosis as claimed in any one of claims 23 through 28, in which the probe is prolonged, and means are provided for delivering (60, 6a, 6b) the semi-solid product (61) forming a connecting layer between the end (8a) of the continuation (8b) of the probe (8) and the skin of the patient.

30 30. The apparatus for medical screening and diagnosis as claimed in the preceding claim, characterized in that it comprises a plunger (36) which controls the semi-solid product and is accessible from the housing (100), in particular from the upper face (Fs), the switch (38) for powering the probe 8 also being arranged on the housing.

35 31. The apparatus for medical screening and diagnosis as claimed in the preceding claim, characterized in that it comprises a reservoir (60) arranged in the housing (100), the gel being delivered through a flexible tube (6a) via an ejection nozzle (6b) situated in contact with the lower face (Fi)

of the turret (100), and the thrust of the plunger (36) making it possible to dose the correct quantity of gel delivered via the nozzle (6b).

32. The apparatus for medical screening and diagnosis as claimed in any one of claims 23 through 31, in which the probe (8) is connected to a loudspeaker (34), mounted on an outer face of the ear trumpet (1') via the transducer circuit (37), the Doppler signal is converted by the transducer circuit (37) in order to supply an audio signal via the loudspeaker (34), the sound being amplified in the ear trumpet, propagated in the linking conduit (3, 33), then listened to at the earpieces (4).

33. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the interpretation software which controls the microprocessor of a microcomputer to be coupled to an output (101) provided on the housing (100) comprises means for retrieving and storing the results of stethoscopic and/or Doppler listening.

34. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the microcomputer is equipped with a screen which shows the graph of the Doppler signal after the Doppler signal has been converted by the circuit (37) and also transmitted to the microcomputer and stored in the form of a video signal via the output (101).

35. The apparatus for medical screening and diagnosis as claimed in claim 33 or 34, in which the software provides a diagnosis on the basis of the evaluations which have been retrieved and stored, with the aid of the display module with at least one light-emitting diode (39, 39a), which is mounted on the housing (100) and coupled to the transducer circuit (37) for viewing the interpretation.

36. The apparatus for medical screening and diagnosis as claimed in any one of claims 23 through 35, in which the transducer circuit (37) converts into video signals the stethoscopic sound signal received by the microphone as claimed in claim 4 and the Doppler signal received by the probe (8).

37. The apparatus for medical screening and diagnosis as claimed in the preceding claim, in which the video signals are transmitted to the microcomputer via the output (101) and/or toward a viewing and printing module (50) situated at a remote point.

38. The apparatus for screening and diagnosis as claimed in claim 36 or 37, in which an antenna (41) is provided to emit the video signals

picked up by the receiver (51) of the viewing module (50), then processed in a demodulator (52) and in a viewing adapter (53).

5 39. The apparatus for medical screening and diagnosis as claimed in any one of claims 36 through 38, in which a headset output (42) is also provided to permit stethoscopic listening based on the sound captured by the microphone or based on the Doppler signal converted into an audio signal by the circuit (37).

10 40. The apparatus for medical screening and diagnosis as claimed in any one of claims 36 through 39, in which the video signals, and if appropriate audio signals after pickup, are transmitted to the microprocessor (100) for evaluation and are viewed on the screen of the microprocessor.

15 41. The apparatus for medical screening and diagnosis as claimed in any one of claims 36 through 40, in which the display module with light-emitting diodes (39, 39a) shows a direct or cross interpretation based on the Doppler and stethoscopic video signals as claimed in claim 7 or 8.